

**Gulf of Mexico Alliance, Action Plan II**  
**Candidate Action Items, *Full Listing***  
**Water Quality Priority Issue Team**

**Harmful Algal Blooms (HABs)**

**Goals:**

- Improve harmful algal bloom detection and forecasting in the U.S. and Mexican States surrounding the Gulf of Mexico and provide information necessary for coastal managers to distribute warnings in a timely manner.
- Reduce the human and environmental impacts of harmful algal blooms through increased understanding of harmful algal bloom organisms and their impacts
- Reduce the human and environmental impacts of harmful algal blooms through development and implementation of effective prevention, control and mitigation methods and efforts

**Outcomes:**

- Improved timeliness and accuracy of bloom detection and monitoring and develop forecasting networks to alert public health managers, natural resource managers, and local governments to:
  - Reduce the incidence rate of human illness related to harmful algal blooms including consumption of toxic shellfish and inhalation of airborne toxins;
  - Reduce direct and indirect environmental impacts attributable to harmful algal blooms including impacts on marine biota and water quality;
  - Provide information on which to base management actions to reduce or mitigate effects of harmful algal blooms on natural and human resources; and
  - Provide opportunities for the coordination of community, state and regional responses to harmful algal bloom impacts on the local economies.
- A public more knowledgeable about harmful algal blooms and their causes and impacts, including effects on human and environmental health.

**Problems or Needs:**

1. **Need to better understand harmful algal bloom ecology and toxicology to both identify environmental conditions promoting blooms of different harmful algal species and to identify potential management control actions.**

**Actions:**

- a) Examine the relationship between harmful algal blooms (in addition to ongoing research with *Karenia* sp.) and the environmental conditions that contribute to bloom occurrence.
- b) Examine the relationships between human activities (e.g., land-use changes and climate change) and harmful algal blooms
- c) Determine the environmental controls and influences on harmful algal bloom toxin production and routes of toxin transfer in coastal environments.

**2. Need to provide decision-making information and data to coastal managers to allow for the amelioration or minimization of harmful algal bloom impacts**

**Actions**

- a) Provide forecasts of harmful algal bloom effects that can be used to take steps to ameliorate or minimize impacts by:
    - o Identifying useful information and data,
    - o Integrating standardized data (e.g. harmful algal bloom presence, distribution, intensity and toxicity) into useful forecast products, and
    - o Identifying effective and useful means for communicating these products to environmental and health managers as described by the GCOOS HABIOS module.
  - b) Standardize data formats and methods for timely provision and communication of non-forecasting harmful algal bloom information.
  - c) Create predictive models of key economic effects of harmful algal blooms by:
    - o Identifying economic effects of different harmful algal bloom species, and
    - o Determining how to better document the economic effects of harmful algal blooms.
- 3. Need to improve harmful algal bloom species and toxin detection technologies to provide decision-making information to coastal managers**

**Actions**

- a) Independently evaluate and standardize the multiple methods of harmful algal bloom species and toxin detection technologies by:
  - o Optimizing detection resolution for harmful algal bloom technologies to meet the needs of different applications (e.g. commercial shellfish bed monitoring, bloom tracking),
  - o Facilitating the technology transfer of laboratory methodology (as identified in the Alliance for Coastal Technology (ACT) workshop or as new techniques are developed) to operational in situ harmful algal bloom and harmful algal bloom toxin sensors, and
  - o Encouraging the testing and production of harmful algal bloom detection technologies capable of detecting multiple species (including the Imaging Flow CytoBot) in the Gulf of Mexico.

- b) Support HABIOS by standardizing harmful algal bloom related methodologies and monitoring protocols among monitoring entities Gulf-wide for harmful algal bloom species.
  - c) Support workshops for harmful algal bloom training with curriculums including standardized monitoring protocols, methodology for *in situ* sensors, field collection, laboratory analyses, and taxonomy training (including microscopic identification of harmful algal bloom species, the 'gold-standard' for cell detection technologies).
- 4. Need to improve the capabilities of Gulf-wide monitoring networks to provide the information needed for local coastal managers, recognizing that many HAB events are significant at both local and Gulf-wide scales.**

**Actions:**

- a) Facilitate completion of the HABIOS monitoring network design and its implementation, ensuring that it:
    - o Integrates with the coastal monitoring networks, IOOS, HABSOS and GCOOS; and
    - o Provides forecasts that are useful to coastal managers at appropriate spatial and temporal scales.
  - b) Facilitate transfer of the Texas HAB forecast system from demonstration to operational mode.
  - c) Improve the predictive modeling capacity of harmful algal blooms by:
    - o Identifying management needs for models (e.g., determining fisheries impacts, tourism impacts), and
    - o Conducting research required to meet these needs.
  - d) Increase collaboration with Mexican states to improve harmful algal bloom forecasting capabilities in the Gulf of Mexico via:
    - o Enhancement of harmful algal bloom monitoring infrastructure in Mexican coastal waters;
    - o Development of a volunteer network for harmful algal bloom monitoring purposes in Mexican coastal waters;
    - o Support training workshops on harmful algal bloom taxonomy and detection technologies; and,
    - o Development of methods to improve Mexican-U.S. harmful algal bloom communications.
- 5. Need to increase communication among those involved in harmful algal bloom-related monitoring and decision making and to provide training opportunities to improve management of resources.**

**Actions:**

- a) Identify and create effective means to increase data exchange and communication on harmful algal blooms, including:
  - o Public communication - notices to go to the public,

- Managerial communication – discussions of interest to coastal managers and researchers, and
- An ‘internet-based’ notification capability which provides a central hub for harmful algal bloom information.

b) Provide regular harmful algal bloom-related training targeted to coastal managers.

**6. Need to develop methods and technologies for the prevention, control and mitigation of harmful algal blooms and their impacts**

**Actions**

- a) Develop and evaluate methods to help prevent, control or mitigate harmful algal blooms including projects or efforts that are designed to:
- Minimize the size, intensity, or duration of harmful algal blooms, and
  - Reduce the environmental, economic, social, or public health impacts of harmful algal blooms.
  - Determine the significance of ballast water introductions and transfers of harmful algal bloom species in the Gulf of Mexico by:
    - Developing and standardizing protocols for sampling ballast waters and detecting potentially invasive harmful algal bloom species in the Gulf region,
    - Identifying new introductions of potentially invasive harmful algal bloom species of concern, and
    - Identifying potential high-risk introduction and transfer routes.

**7. Need to better understand HAB effects on human health**

**Actions:**

- a) Assess adverse health impacts from harmful algal blooms by conducting exposure assessments and epidemiologic studies.
- b) Help states to contribute data on human and animal illness to the Harmful Algal Bloom-related Illness Surveillance System (HABISS) developed at the Centers for Disease Control and Prevention by:
- Holding HABISS training workshops, and
  - Creating data packages from HABISS and HABIOS data that can be used to support public health decision-making.
- c) Improve the reporting capabilities for environmental monitoring and public health risks by:
- using data from HABIOS and HABISS to create manager-response models to train managers, and
  - using the outcome of training models to modify the reporting systems.
- d) Develop tools for state epidemiology units that will help them use HABISS and HABIOS data by:
- adapting an existing syndromic surveillance paradigm for use with HABISS;

- creating links to other relevant data such as weather or climate data; and
- supporting the transition from development through practical application of modeling tools for public health decision-makers that use data from HABISS and HABIOS.

## **Pathogens**

### **Goal:**

- Protect human health by improving coastal water-quality management

### **Desired outcomes:**

- Methods for near real-time detection of pathogen (or pathogen indicator) are identified that can allow resource managers to more rapidly and accurately assess potential risks to recreational users of coastal waters (continuation from Action Plan I).
- Better understanding of human health risks associated with swimming-related exposure to different sources of fecal contamination (human vs. non-human).
- An understanding of how pathogen indicators currently being developed relate to health effects at beach and shellfish harvesting waters.
- Improved water-quality models for generating beach notifications and advisories/closures.
- Better understanding of the incidence of *Vibrio*-caused disease and the factors affecting the distribution of *Vibrio* species in the Gulf of Mexico.

### **Problems or Needs:**

1. **Improve the methodology used to identify areas that are impaired by pathogens or to track sources of pathogens**

#### **Actions:**

- a) Compile and compare existing Gulf States' programs to identify worthwhile methods and provide direction.
- b) Repeat workshop on pathogen indicators to identify any additional methods for laboratory and field trials.
- c) Assist states in implementing rapid testing of recreational waters for pathogens by 2010 through workshops, on-site evaluations and development of standard operating procedures.
- d) Identify and prioritize human-health-risk indicators.
- e) Identify and prioritize pathogens of interest and set up a QMRA (Quantitative Microbial Risk Assessment) to improve understanding of the impact of pathogen reduction on health risk in impaired environmental areas.
- f) Conduct a study to compare detection rates from an indicator method to an actual pathogen method and assess each for cost effectiveness, technological feasibility and reliability.

**2. Improve our understanding of sources of pathogens and their risks to human health – including survival in ambient conditions – by building on existing efforts**

**Actions**

- a) Assess the survivability of pathogens and current indicator organisms in the environment by carrying out regrowth and persistence studies.
  - b) Conduct a literature review and evaluate results concerning the viability of key bacteria used as indicators in both the water column and sediments. (Can sediments harbor viable bacteria populations for extended periods that result in exceedances when sediments are disturbed, such as during dredging or storms?).
  - c) Quantify fecal input from bathing beachgoers.
  - d) Conduct a literature review for approximate fecal densities from stormwater runoff from different locations.
  - e) Increase monitoring and pollution source tracking efforts in order to identify and remediate impaired beaches.
  - f) Evaluate the true human health risk of human vs. manageable non-human fecal pollution sources through a quantitative microbial risk assessment (QMRA).
- 3. Provide Coastal Managers with information to make better informed health and resource-management decisions.**

**Actions:**

- a) Compare Gulf States' water quality standards for beach waters and shellfish growing waters.
- b) Provide local decision-makers with coastal development methods consistent with smart growth and low-impact development techniques in order to maintain safe molluscan shellfish harvesting waters.
- c) Conduct a state-federal workshop on utilizing existing programs (Clean Water SRF, Clean Marina, no discharge zones, etc.) to target bacterial source reduction.
- d) Develop models including seasonal and geographic distributions to predict pathogen exceedances as a tool for better management decisions.
- e) Develop data portal to access and compare beach monitoring WQ data from all Gulf States' programs.
- f) Map areas of high-risk for exceedances of microbial pollution standards to identify potential research sites and to guide remediation efforts.
- g) Conduct microbial source-tracking studies in selected shellfish-harvesting locations to evaluate the relationship between quantitative MST marker concentrations and fecal coliform concentrations.
- h) Mine historic data to better understand a specific managed coastal area and its environment and expand the analysis into correlation of species (population dynamics) available in that area, pathogen indicators, epidemiological correlations and source tracking research using the old and current data and to be able to establish better ways to manage a marine area.

#### 4. Better understand *Vibrio* bacteria ecology and health risks.

**Actions:**

- a) Conduct a literature review including CDC data to determine recent trends in incidence of vibriosis.
- b) Study potential for temperature, salinity, and possibly other environmental factors that could be used to predict health risks (both recreational and seafood) from *Vibrio* species
- c) Study potential for differential seasonal and geographic distributions for different *Vibrio* species.

### Monitoring and Other Water Quality

**Goal:**

- To provide information about coastal water-resource status and trends that support informed management decisions.

**Desired outcomes:**

- An integrated, collaborative monitoring system exists that provides data on the coastal and offshore Gulf of Mexico water resources.
- Improved management of coastal resources.
- Improved data comparability across the Gulf of Mexico.
- Biological indicators are available that will assist in water-quality and water-resource management decisions.

**Problems or Needs:**

#### 1. Improve data comparability across the Gulf of Mexico

**Actions:**

- a) Continue data comparability efforts, including analytical and field round robins, methodology standardization, etc. (see Action Plan I for additional items).<sup>9</sup>
- b) Document detection limits of methods that were identified for the core group of analytes targeted for nutrient studies by the joint water quality/nutrient teams and determine the methods' adequacy for establishing ambient concentrations of the core analytes.<sup>8</sup>

#### 2. Improve water-resource monitoring networks

**Actions:**

- a) Continue the comprehensive water quality monitoring survey of state, local, and federal agencies and organizations currently involved in the collection of water quality related data and information.
- b) Use this data to carry out a gap analysis identifying areas that need monitoring, or areas that need increased monitoring.

- c) Develop a coastal monitoring network. Promote participation in the network by hosting and/or attending workshops with groups involved in routine coastal monitoring.
  - d) Continue annual Monitoring Forum which will be publicized to the other PITs to expand the participant base.
  - e) Create a QA/QC guidance document for sample collection, sample analyses, and data handling so that comparability among the states can be assessed
  - f) Survey coastal monitoring programs' QA/QC methodologies for sample collection, sample analyses, and data handling, and assess them for comparability
  - g) Develop a proposal for a long-term land use and land cover monitoring program that includes an estimate of implementation costs and relates land use and land cover changes to ecological impacts.
  - h) Develop a plan including a schedule and an estimate of the cost for increasing the number of stations in the National Data Buoy Center and Coastal-Marine Automated Network (C-MAN) networks to provide sufficient coverage for coastal managers' needs in the Gulf of Mexico.
3. **Coordinate the collection of information about monitoring systems and the management of that information across the Gulf of Mexico.**

**Actions:**

- a) Test and optimize data collection aspects of Gulf of Mexico Alliance nutrient studies to improve the measurement of causal and response parameters that are important to nutrient management.<sup>2</sup>
  - b) Establish a standard monitoring system metadata format, and provide training for metadata development and maintenance at the state program level.<sup>4</sup>
  - c) Use the standard metadata format to make historical data from standardized programs, such as National Coastal Assessment, more accessible.
  - d) Establish a standard method of estimating pollutant loads, accounting for temporal variation.<sup>8</sup>
4. **Develop management tools that inform decision makers about existing water-quality conditions and potential changes that could result from development decisions.**

**Actions:**

- a) Develop one pilot project per Gulf state (using existing data, models, and tools) to create a GIS-linked landscape and/or water quality modeling tool that can be used by local managers as a guide for land use in coastal watersheds.
5. **Increase the amount of water quality data available to properly manage resources**

**Actions:**

- a) Compile data sets of known quality from standardized monitoring programs to serve as a base for model development and implementation, trend analysis, and monitoring of priority coastal areas.

- b) Develop a data portal for accessing historical, current, and real time monitoring data so that they can be available for researching trends in coastal and offshore waters.
- c) Investigate existing comprehensive, predictive models (including flow models and nutrient loading models) used in best resource management practices to determine if current needs are met.

**6. Improve the knowledge base needed to properly manage or reduce nutrients in coastal waters (in collaboration with other Priority Issue Teams)**

**Actions:**

- a) Develop a plan to increase the use of real time water quality monitoring as a nutrient loading component of the coastal monitoring network, including the identification of key locations and approximate costs.
- b) Develop user-friendly educational materials for the promotion of water quality priorities. [in collaboration with Education Team]
  - o These materials should target a wide audience encouraging community involvement and stressing the responsibilities of individual stakeholders. This outreach could be a means of attaining conservation and preservation goals in coastal rebuilt areas and managed priority areas and the prevention of resource problems.
- c) In collaboration with other Priority Issue Teams, develop a training plan and provide training to appropriate local, state, and federal decision-makers in the use of management tools developed in Action 4a.
- d) Hold a workshop on the "state of the science" of biological indicators and biological-assessment tools.
- e) Develop an inventory of existing programs that use biological indicators.
- f) Develop protocols for developing biocriteria and determining attainment of aquatic life-use targets for coastal waters, including tidal streams.

**7. Improve the understanding of ambient dissolved oxygen concentrations and their effect on living resources (in collaboration with Nutrients Team)**

**Actions:**

- a) Conduct a literature review to identify previous studies that examine the role of freshwater flows and salinity gradients in estuarine community health and methodologies that have been employed in these studies.
- b) Compile information from small tidal streams, including those that are least impacted by human activities, to establish baseline conditions and assess the magnitude, frequency, and duration of naturally-occurring low dissolved oxygen levels and the biological communities that are supported in these areas.

**8. Identify specific wastewater and stormwater disposal alternatives which would benefit water quality**

**Actions:**

- a) Develop a risk assessment protocol to determine which wetlands are suitable to hydraulically restore with wastewater or stormwater
  - b) Document the use of wastewater and stormwater in the Gulf of Mexico states.<sup>7</sup>
  - c) Conduct a literature review of research in wastewater and stormwater reuse for the development of appropriate expressions of nutrient criteria (numeric, narrative, biological, etc.)
9. **Identify potential water quality improvements which could occur as a result of habitat restoration.**

**Actions:**

- a) Document ongoing habitat restoration efforts which are likely to result in water quality improvements (in collaboration with the Restoration Team).
- b) Determine a protocol for identifying the most endangered habitats after a hurricane. (Referred to the Restoration Team)
- c) Determine an ecological risk assessment protocol to create plans of action after the most endangered habitats have been identified (in collaboration with Restoration Team.)

## Mercury and Other Contaminants

**Goals:**

- To better our understanding of mercury and other contaminants in the environment, their potential risks to human health and the ecosystem and to distribute that information to the appropriate groups.
- Identify the major sources of mercury ending up in Gulf of Mexico seafood.

**Comment [WS1]:** Note, we have no Actions which look at actual effects on humans or the ecosystem, hence my suggested rewording. The implication this way is that areas of higher concentration are those of greater risk.

**Desired outcomes:**

- Reduced human exposure to mercury and other contaminants in the Gulf of Mexico seafood supply.
- Information provided to consumers that guides them in safely consuming Gulf of Mexico seafood products.
- Fishermen and seafood distributors better understand how to evaluate and ensure the consumer safety of the seafood they harvest and process.
- Effective regulation of mercury inputs is possible as a result of identifying the sources of mercury ending up in Gulf of Mexico seafood.

**Problems or Needs:**

1. **Need to establish and regularly update our understanding of how mercury cycles in the Gulf of Mexico and define research priorities to improve that understanding.**

**Actions:**

- a) Compile and summarize past and present efforts to define the spatial distribution and magnitude of mercury in fish and shellfish, mercury sources, mercury methylation and

demethylation kinetics, mercury cycling, and mercury bioaccumulation in the food webs of the Gulf of Mexico. Post on the GOMA web site and update the information at least annually.

- b) Generate a contact list of researchers working on mercury in the Gulf of Mexico. Post on the GOMA web site and update the information at least annually.
  - c) Host an annual mercury forum for researchers to exchange information, synthesize the results for previous and ongoing research on mercury cycling in the Gulf of Mexico, and to develop research priorities. Post on the GOMA web site and update the information after each forum.
  - d) Post tables of information on the GOMA web site that display and explain the various mercury fish tissue criteria for the Gulf states, including fish consumption limits and guidelines established by appropriate agencies.
2. **Need to quantify the major input pathways for mercury to the Gulf of Mexico to allow creation of mercury-cycling models that predict mercury levels in fish and shellfish (in collaboration with Nutrients PIT).**

**Actions:**

- a) a. Determine atmospheric inputs of mercury.
  - o Compile measurements of wet deposition of mercury and methylmercury from existing studies. Update annually.
  - o Estimate nearshore dry deposition fluxes by quantifying dry deposition of reactive gaseous mercury (RGM) using existing and additional measurements.
  - o Deploy samplers on offshore platforms to monitor wet and dry deposition fluxes of mercury over the Gulf of Mexico. Include supplemental air monitoring equipment (NO<sub>x</sub>, SO<sub>2</sub>, O<sub>3</sub>, etc.) to aid in the interpretation of the RGM data.
- b) Determine riverine inputs of mercury.
  - o Carry out pilot study to identify main factors controlling mercury concentrations in rivers to develop appropriate monitoring regime for measure mercury fluxes from rivers. Include at least a major and small river.
  - o Using this regime, monitor to measure dissolved mercury, particulate mercury, and methylmercury fluxes from at least the eight largest U.S. Gulf of Mexico tributaries for at least three years.
- c) Establish the net fluxes of dissolved and particulate mercury and methylmercury to the coastal waters of the Gulf of Mexico.
  - o Determine the net flux of mercury from estuaries to coastal waters by conducting studies of mercury transport and cycling through estuaries. Choose estuaries that are associated with the above river monitoring program and integrate studies with the GOMA coastal nutrient criteria framework studies. Conduct studies for at least 2 years with emphasis on quantifying the estuarine flushing effects from major storm events.
- d) Map ambient mercury concentrations along typical coastal areas.

- Collect vertical profiles of total mercury and methylmercury in a series of transects from the coastline to offshore to measure mercury-concentration gradients. Overlap coastal transects with the river and estuarine study sites above and integrate with the GOMA coastal nutrient criteria framework studies.
  - e) Quantify the net flux of total and methylmercury from the inflow and outflow of water between the Caribbean Sea and the Gulf of Mexico.
    - Water flow through the Yucatan Straits into the GoM is very large and represents a potentially significant flux of mercury into the GoM; much of the inflowing water, however, follows the Loop Current around the central GoM and quickly exits through the Florida Straits. Determine the net flux to the Gulf and Gulf coastal areas by monitoring mercury concentrations in the Yucatan and Florida Straits for at least 3 years.
  - f) Quantify the impact of submarine groundwater discharge on mercury fluxes in the Gulf of Mexico.
    - Measure concentrations of total mercury and methylmercury in groundwater discharges to the Gulf of Mexico. If the concentrations are high, additional studies may be necessary to properly quantify this mercury source.
  - g) Construct a coupled hydrodynamic/mercury water quality model to integrate all measurements.
    - Calculate fluxes of mercury into and within the Gulf by using a model to incorporate the mercury concentration and concentration-gradient data into high resolution hydrodynamic circulation models for the Gulf of Mexico (e.g., NCOM or HyCOM).
    - Use the resulting model to simulate mercury cycling and bioaccumulation in the GoM. Use the model to help identify data gaps and any additional information or research needs.
    - Where appropriate, integrate the mercury model with hydrodynamic and water quality models developed for the GOMA nutrient criteria framework studies.
- 3. Determine where mercury methylation occurs and what processes govern its occurrence**
- Actions:**
- a) Conduct estuarine and nearshore mercury methylation-demethylation rate studies in sediments and other appropriate environments. Conduct laboratory and *in situ* sediment incubation experiments to quantify mercury methylation and demethylation rates. Measure pore-water total mercury and methylmercury concentration gradients to estimate benthic fluxes. Coordinate with estuarine mercury cycling studies above.
  - b) Integrate methylation information into the coupled hydrodynamic/mercury water quality model to help identify data gaps and any additional information or research needs.

**4. Determine how and where methylmercury enters into the food webs and bioaccumulates in fish (in collaboration with Nutrients PIT)**

**Actions:**

- a) Conduct trophic transfer studies of important fishery species (e.g., king mackerel, red and gray snapper, and gag grouper).
- b) Conduct water column transect studies in the GoM to measure methylmercury in the lower food web (phytoplankton, zooplankton, and benthos). Integrate with the sampling in 2d above and the GOMA coastal nutrient criteria framework studies.
- c) Incorporate trophic information into the coupled hydrodynamic/mercury water quality model to help identify data gaps and any additional information or research needs.

**5. Better our understanding of mercury effects on key non-fishery species (e.g., whales and dolphins, seabirds).**

**Actions:**

- a) Quantify mercury concentrations in key non-fishery species and assess for potential effects on those species.

**6. Better our understanding of other significant contaminants in the Gulf of Mexico and what might be done to reduce human health risks and aquatic organism risks.**

**Actions:**

- a) Compile information from existing programs that measure contaminants in Gulf plants and animals (e.g., Mussel Watch). Identify contaminants most likely to be present in concentrations that cause effects, e.g., dioxin, PCBs, PBDE.
- b) Develop and conduct sampling of indicator populations around the Gulf for the identified contaminants. Where possible add analyses for these contaminants to existing mercury fish-tissue sampling programs.

**7. Communicate information about mercury and other seafood contaminants having human-health effects to fishermen, seafood distributors, and the public (in collaboration with Education PIT).**

**Actions:**

- a) Devise effective means to provide appropriate information about mercury and other contaminants with potential human-health effects to those who catch, handle, and consume seafood.